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**Instrument Specifications, Characterization and Calibration**

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## Chapter 5

# Stability Monitoring of Field Radiometers Using Portable Sources

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## 5.1 INTRODUCTION

Mueller and Austin (1995) included a discussion on tracking instrument performance in between calibration activities with stable lamp sources in rugged, fixed geometric configurations. The recommended specifications of the device included the stability of the lamp output and the repeatability of measurement must be sufficient to detect 2 % variations in an instrument's performance. In terms of the protocols for using the source, it was recommended that an instrument should be connected to the portable standard and its response recorded daily, keeping a record of instrument responsivity throughout an experiment. Furthermore, these sources would provide an essential warning of problems if they appear.

One of the more important requirements in the use of the portable source was it must be available when the complete radiometric calibrations are performed, so a baseline may be established and maintained for each sensor channel, but recognizing that the source cannot be a substitute for complete calibrations. The temporal record they provide will, however, be invaluable in cases where the pre-and post-cruise calibrations disagree or if the instrument is disturbed, e.g., opened between calibrations, subjected to harsh treatment during deployment or transport, or if the data quality are otherwise suspect. These portable standards are an important part of the recommended instrument package.

## 5.2 The SQM

Although Mueller and Austin (1995) specified the need for, and described some of the requirements of, a portable source, no such device was then commercially available. In response to the need for a portable source, NASA and NIST developed the SQM. The engineering design and characteristics of the SQM are described by Johnson et al. (1998), so only a brief description is given here. A separate rack of electronic equipment, composed principally of two computer controlled power supplies and a multiplexed, digital voltmeter (DVM), are an essential part of producing the stable light field. All of the external components are controlled by a computer program over a general purpose interface bus (GPIB).

The SQM has two sets of halogen lamps with eight lamps in each set; both lamp sets are arranged symmetrically on a ring and operate in series, so if one lamp fails, the entire set goes off. The lamps in one set are rated for 1.05 A (4.2 V) and are operated at 0.95 A, and the lamps in the other set are rated for 3.45 A (5.0 V) and are operated at 3.1 A; the lamp sets are hereafter referred to as the 1 A and 3 A lamps, respectively. The lamps are operated at approximately 95 % of their full amperage rating to maximize the lifetime of the lamps.

A low, medium, and high intensity flux level is provided when the 1 A, 3 A, and both lamp sets are used, respectively. Each lamp set was aged for approximately 50 hours before deploying the SQM to the field. The interior light chamber has bead-blasted aluminum walls, so the diffuse component of the reflectance is significant. The lamps illuminate a circular plastic diffuser protected by safety glass and sealed from the environment by o-rings. The diffuser is resilient to ultraviolet yellowing, but can age nonetheless. The exit aperture is 20 cm in diameter and has a spatial uniformity of 98 % or more over the interior 15 cm circle. The SQM does not have, nor does it require, an absolute calibration, but it has design objectives of better than 2 % stability during field deployments.

A faceplate or *shadow collar* provides a mounting assembly, so the device under test (DUT), usually a radiance or irradiance sensor, can be positioned in the shadow collar. The DUT has a D-shaped collar fitted to it at a set distance, 3.81 cm (1.5 inch), from the front of the DUT. This distance was chosen based on the most restrictive clearance requirement of the radiometers used in the different deployment rigs. The D-shaped collar ensures the DUT can be mounted to the SQM at a reproducible location and orientation with respect to the exit aperture each time the DUT is used. The former minimizes uncertainties (principally with irradiance sensors) due to distance differences between measurement sessions, while the latter minimizes uncertainties (principally with radiance sensors) due to inhomogeneities in the exit aperture light field. In either case, the D-shaped collar keeps these sources of uncertainties below the 1 % level. A schematic of the original SQM is given in Fig.5.1. The SQM faceplate can be changed to accept a variety of instruments from different manufacturers. Radiometers above a certain size, approximately 15 cm, would be difficult to accommodate, but the entire mounting assembly can be changed to allow for reasonable viewing by seemingly difficult to handle radiometers. To date, three radiometer designs have been used with the SQM, and there were no problems in producing the needed faceplates, D-shaped collars, or support hardware to accommodate these units.